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APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.	CONFIRMATION NO.
09/981,842	10/19/2001	Kenji Imanishi	011287	7067

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EXAMINER	
BAUMEISTER, BRADLEY W	
ART UNIT	**PAPER NUMBER**
2815	

DATE MAILED: 03/19/2004

Please find below and/or attached an Office communication concerning this application or proceeding.

Office Action Summary	Application No.	Applicant(s)	
	09/981,842	IMANISHI, KENJI	
	Examiner	Art Unit	
	B. William Baumeister	2815	

-- The MAILING DATE of this communication appears on the cover sheet with the correspondence address --

Period for Reply

A SHORTENED STATUTORY PERIOD FOR REPLY IS SET TO EXPIRE 3 MONTH(S) FROM THE MAILING DATE OF THIS COMMUNICATION.

- Extensions of time may be available under the provisions of 37 CFR 1.136(a). In no event, however, may a reply be timely filed after SIX (6) MONTHS from the mailing date of this communication.
- If the period for reply specified above is less than thirty (30) days, a reply within the statutory minimum of thirty (30) days will be considered timely.
- If NO period for reply is specified above, the maximum statutory period will apply and will expire SIX (6) MONTHS from the mailing date of this communication.
- Failure to reply within the set or extended period for reply will, by statute, cause the application to become ABANDONED (35 U.S.C. § 133). Any reply received by the Office later than three months after the mailing date of this communication, even if timely filed, may reduce any earned patent term adjustment. See 37 CFR 1.704(b).

Status

1)☒ Responsive to communication(s) filed on *03 December 2003*.

2a)☒ This action is **FINAL**. 2b)☐ This action is non-final.

3)☐ Since this application is in condition for allowance except for formal matters, prosecution as to the merits is closed in accordance with the practice under *Ex parte Quayle*, 1935 C.D. 11, 453 O.G. 213.

Disposition of Claims

4)☒ Claim(s) *1-18 and 21* is/are pending in the application.

4a) Of the above claim(s) *4 and 13-15* is/are withdrawn from consideration.

5)☐ Claim(s) _____ is/are allowed.

6)☒ Claim(s) *1-3,5-12,16-18 and 21* is/are rejected.

7)☐ Claim(s) _____ is/are objected to.

8)☐ Claim(s) _____ are subject to restriction and/or election requirement.

Application Papers

9)☐ The specification is objected to by the Examiner.

10)☒ The drawing(s) filed on *19 October 2001* is/are: a)☐ accepted or b)☒ objected to by the Examiner.

Applicant may not request that any objection to the drawing(s) be held in abeyance. See 37 CFR 1.85(a).

Replacement drawing sheet(s) including the correction is required if the drawing(s) is objected to. See 37 CFR 1.121(d).

11)☐ The oath or declaration is objected to by the Examiner. Note the attached Office Action or form PTO-152.

Priority under 35 U.S.C. § 119

12)☒ Acknowledgment is made of a claim for foreign priority under 35 U.S.C. § 119(a)-(d) or (f).

a)☒ All b)☐ Some * c)☐ None of:

1.☒ Certified copies of the priority documents have been received.

2.☐ Certified copies of the priority documents have been received in Application No. _____.

3.☐ Copies of the certified copies of the priority documents have been received in this National Stage application from the International Bureau (PCT Rule 17.2(a)).

* See the attached detailed Office action for a list of the certified copies not received.

Attachment(s)

1) ☒ Notice of References Cited (PTO-892)
2) ☐ Notice of Draftsperson's Patent Drawing Review (PTO-948)
3) ☐ Information Disclosure Statement(s) (PTO-1449 or PTO/SB/08) Paper No(s)/Mail Date _____.
4) ☐ Interview Summary (PTO-413) Paper No(s)/Mail Date. _____.
5) ☐ Notice of Informal Patent Application (PTO-152)
6) ☐ Other: _____.

DETAILED ACTION

Drawings

1. The drawings are objected to under 37 CFR 1.83(a). The drawings must show every feature of the invention specified in the claims. Therefore, the electron-supplying layer being laminated in contact with the first channel layer—as opposed to possessing an interposed offset spacer—must be shown or the feature(s) canceled from the claim(s). No new matter should be entered.

A proposed drawing correction or corrected drawings are required in reply to the Office action to avoid abandonment of the application. The objection to the drawings will not be held in abeyance.

Claim Rejections - 35 USC § 103

2. The text of those sections of Title 35, U.S. Code not included in this action can be found in a prior Office action.

3. Claims 1-3, 5, 6, 9, 17 and 18 are rejected under 35 U.S.C. 103(a) as being unpatentable over JP 6-236898 and Applicant's prior-art admissions in view of JP '934 (previously made of record).

a. Applicant acknowledged in the BACKGROUND section of the present application that prior-art reference, JP '898, discloses III-V HEMTs formed on InP substrates with the following layers: first and second undoped channel layers laminated on the InP substrate via an InAlAs buffer layer; a doped electrode-supplying layer (such as InAlAs) laminated on the first channel layer by means of an offset spacer; wherein the

first channel layer is composed of InGaAs(P) and has a conduction-band energy level lower than that of the electrons-supplying layer; the second channel layer has a III-V composition with a bandgap wider than that of the first channel layer; and the first and second channel levels having thicknesses set such that a first quantum level is formed only in the first channel and a second quantum level is formed in both the first and second channel layers. The first channel layer may be composed specifically of InGaAs, free of phosphorus (see e.g., prior-art FIG. 6 and JP '898, paragraphs [0009] and [0041]).

b. JP '898 does not teach that the second channel layer may be composed of a III-V compound that is free of phosphorus. Applicant acknowledges in the BACKGROUND section that the JP '898 HEMT had two known drawbacks that made commercial manufacturing complicated and impractical: (1) in the subsequent etch-steps employed for electrical isolation, the use of InGaAsP for the composition of the second channel layer necessitated a different etch process than was used for the other III-V layers not containing phosphorus; and (2) the use of InGaAsP for the second channel made manufacturing difficult because the growth of III-V mixed crystals having both As and P is difficult (BACKGROUND, pages 5-6).

c. JP '934 teaches that it was known to make InGaAs-channel HEMTs on an InP substrate by means of an InAlAs buffer 2 and a phosphorous-free, AlGaInAs crystal-growth layer 3 having a conduction band energy that is intermediate to that of the channel and the buffer (see e.g., FIG 1). Fig 1 further teaches that even when the respective layers are not lattice-matched, the AlGaInAs layer—which permits growth of a strained InGaAs channel thereover—and the overgrown InGaAs channel, itself, can still be grown

to thicknesses that are more than large enough to support discrete quantum levels, as desired by the JP '898 reference for the first and second channel layers.

d. It would have been obvious to one of ordinary skill in the art at the time of the invention to have modified the InGaAs/GaInAsP double-channel HEMT of JP '898 by substituting AlGaInAs for the GaInAsP as taught by JP '934 as the composition of the second channel layer for the purpose of simplifying the HEMT's manufacturing by obviating the need for separate etch steps and complex crystal-growth techniques, which Appellant acknowledged were known drawbacks of the JP '898 device.

e. The further limitations—that the second channel has a thickness larger than that of the first channel layer (e.g., claim 1) and that the respective thicknesses are specifically 10~20 nm and 3~7 nm (e.g., claims 5 and 6)—are merely optimization-of-design details readily ascertainable by the ordinarily skilled artisan through routine experimentation because JP '898 sets forth the general conditions desired (—that the first and second channel thicknesses be appropriately sized so as to support two and one quantum energy levels, respectively—) and because the particular thicknesses that would produce this desired energy level effect result from well understood factors including the bandgaps, conduction-band offsets and strains associated with the particular materials employed according to well-developed quantum physics principles.

f. Regarding the newly-added limitation that the doped electron-supplying layer is laminated in contact with the first channel layer (e.g., claim 1), depending upon the interpretation of "electron-supplying layer," JP '898 either teaches the limitation or at least renders it obvious:

i. The term "electron-supply layer" is sometime used in the art broadly to mean all of the barrier layer including the undoped offset layer as well as the portion that is actually doped. Under this interpretation, JP '898 expressly discloses this limitation of the claims.

ii. Alternatively, if the term "electron-supplying layer" is to be interpreted more narrowly such that the claims require that the doped portion of the barrier, itself, be in direct contact with the channel, regardless of whether JP '898 specifically discloses the potential for this alternative construction (paragraph [0039] of the JPO machine translation appears to indicate that the spacer is optional), the claims under this interpretation would nonetheless have been obvious because the reasonably skilled artisan knew that the use of such undoped offsets between a HEMT's channel and barrier were typically optional, providing the benefit of reduced scattering, but complicating the manufacturing process.

4. Claims 7, 8, 10-12, 16 and 21 are rejected under 35 U.S.C. 103(a) as being unpatentable over JP '898, Applicant's prior-art admissions and JP '934 as applied to the claims above and further in view of Jewell '796.

a. Regarding claims 10, 11 and 21, further setting forth that two channel layers are lattice-matched to the InP substrate, JP '898 discloses that the two channel layers are preferably lattice-matched to the underlying InP substrate, and JP '934 teaches that AlGaInAs compositions in general have the conduction energy level and lattice constant that would permit it to be substituted for GaInAsP, so as to serve as the second channel

layer. But JP '934 does not appear to teach that an AlGaInAs composition may be specifically set such that it is lattice-matched to InP.

i. FIG. 11 of Jewell '796 provides evidence of well-known band-gap and lattice-constant data for various materials. Note particularly the diamond-shaped region bound by the lines connecting AlAs, InAs, and GaAs. This bound region depicts the known band-gaps and lattice-constants for all of the possible alloys of AlGaInAs, and provides evidence that it was known that constituent elements of AlGaInAs could be specifically adjusted so as to be lattice-matched with InP.

ii. It would have been obvious to one of ordinary skill in the art at the time of the invention to have chosen a particular species of the AlGaInAs alloys that is specifically lattice matched to InP because JP '898 teaches that lattice-matching the second channel layer to the first channel layer and substrate is desirable and because the use of a lattice-matched species of AlGaInAs would reduce crystalline defects in the superposed first channel layer and increase the range of potential thicknesses selectable for the second channel layer and subsequently grown layers.

b. Regarding claims 7 and 10-12, setting forth that the Al concentration is specifically set to 0.05~0.5, JP '898 discloses that the material chosen for the second channel layer should have a composition that produces a conduction-band energy larger than that in the InGaAs first channel layer so as to support only a single discrete energy level, excluding the second discrete energy level supported by the InGaAs first channel. The band-gap/lattice-constant diagram of Jewell's FIG 11 depicts that just about all of

those alloy species of AlGaInAs that are lattice-matched to InP have aluminum concentrations that satisfy this condition. Thus, it would have been obvious to the skilled artisan at the time of the invention substituting a lattice-matched AlGaInAs composition in the manner and for the reasons set forth above to have chosen a specific composition having an Al concentration greater than 0.05 so as to preclude supporting the lower energy level supported by the first channel layer, and having an Al concentration less than 0.5 in order to maintain a composition that is lattice-matched to InP, both goals being taught by JP '898.

c. Regarding claims 8 and 16, setting forth that the second channel is specifically composed of GaInAs with a lower In concentration than that of the first channel layer, JP '898 sets forth that it is preferable for the second channel to be lattice-matched, but the reference is not so limited. Rather, JP '898 further states that the channel layers may also be non-lattice-matched so long as the thicknesses are below the critical thickness producing misfit dislocations (e.g., paragraph [0038]). The band-gap/lattice-constant diagram of Jewell's FIG 11 further teaches that decreasing the In content of ternary InGaAs increases the composition's band-gap (i.e., raises the conduction band energy level).

It would have been obvious to the ordinarily skilled artisan at the time of the invention to have further investigated the alternative use of InGaAs as well as AlGaInAs for the second channel layer because JP '898 teaches that the layers do not have to be lattice-matched, Jewell '796 evidences that it was known that InGaAs would serve as a functional equivalent for AlGaInAs within the parameters desired by JP '898, and

because InGaAs, being a ternary compound, has the benefit over the quaternary AlGaInAs of being more stable and easier to grow.

Response to Arguments

5. Applicant's arguments with respect to the claims have been considered but are moot in view of the new ground(s) of rejection.

Conclusion

6. The prior art made of record and not relied upon is considered pertinent to applicant's disclosure.

a. Imamura '356, directed towards III-As heterojunctions semiconductor devices formed on InP substrates, teaches that the InGaAs and AlGaInAs layers can be readily etched down to the underlying AlInAs buffer layer 12 (e.g., col. 11, lines 4-11), and thereby provides further evidence that the reasonably skilled artisan would have been motivated to substitute AlGaInAs for the GaInAsP second channel layer in the manner set forth above for the stated reasons relating to the layers' etchability.

7. Applicant's amendment necessitated the new ground(s) of rejection presented in this Office action. Accordingly, **THIS ACTION IS MADE FINAL**. See MPEP § 706.07(a). Applicant is reminded of the extension of time policy as set forth in 37 CFR 1.136(a).

A shortened statutory period for reply to this final action is set to expire THREE MONTHS from the mailing date of this action. In the event a first reply is filed within TWO

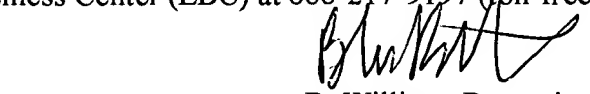
MONTHS of the mailing date of this final action and the advisory action is not mailed until after the end of the THREE-MONTH shortened statutory period, then the shortened statutory period will expire on the date the advisory action is mailed, and any extension fee pursuant to 37 CFR 1.136(a) will be calculated from the mailing date of the advisory action. In no event, however, will the statutory period for reply expire later than SIX MONTHS from the date of this final action.

Contact Information

Any inquiry concerning this communication or earlier communications from the examiner should be directed to B. William Baumeister whose telephone number is (571) 272-1722. The examiner can normally be reached on M-F 8-5.

If attempts to reach the examiner by telephone are unsuccessful, the examiner's supervisor, Tom Thomas can be reached on (571) 272-1664. The fax phone number for the organization where this application or proceeding is assigned is 703-872-9306.

Information regarding the status of an application may be obtained from the Patent Application Information Retrieval (PAIR) system. Status information for published applications may be obtained from either Private PAIR or Public PAIR. Status information for unpublished applications is available through Private PAIR only. For more information about the PAIR system, see http://pair-direct.uspto.gov. Should you have questions on access to the Private PAIR system, contact the Electronic Business Center (EBC) at 866-217-9197 (toll-free).



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